

An Overview of the



Space Science Data Operations Office

2001

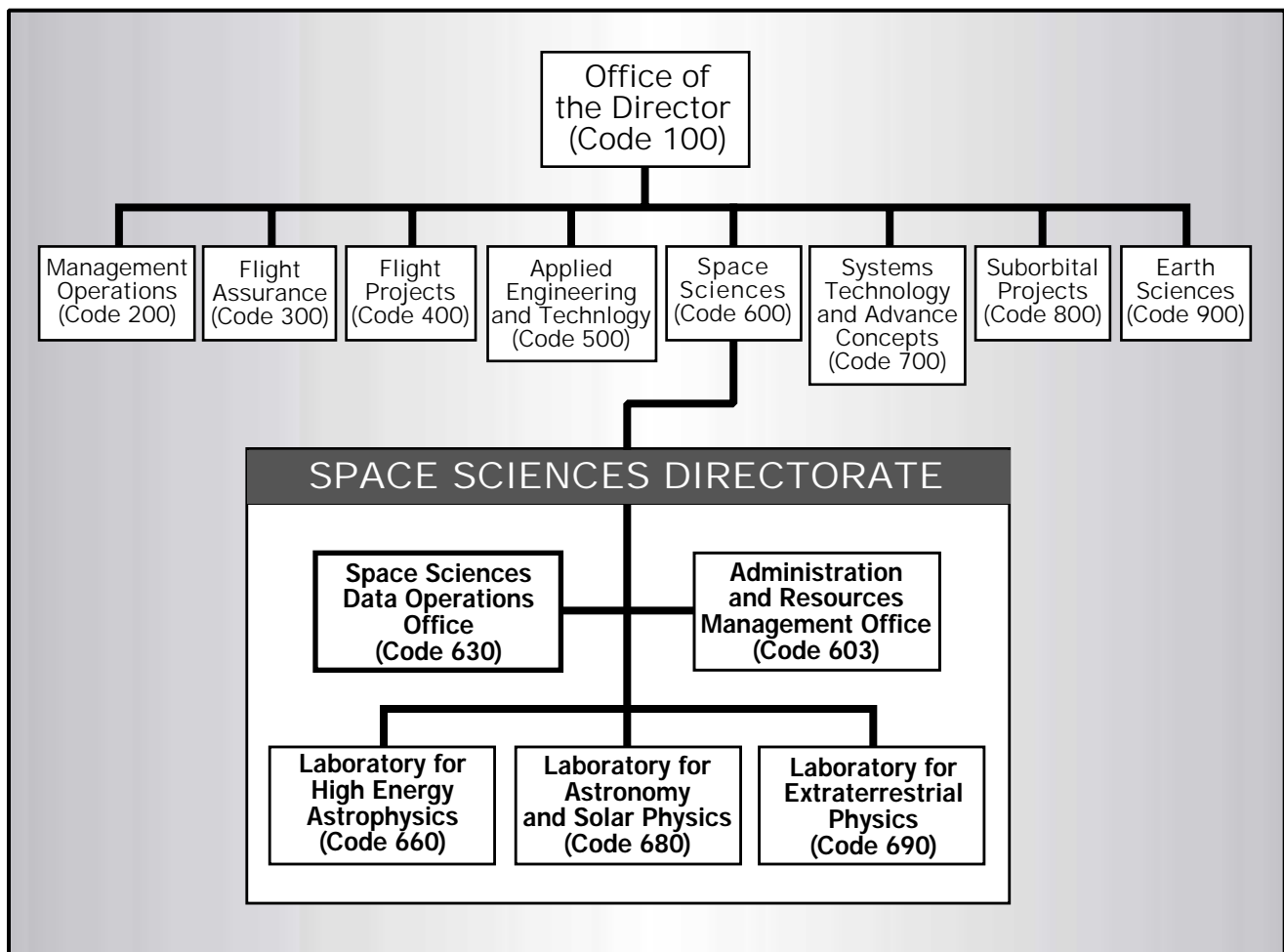
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Preface

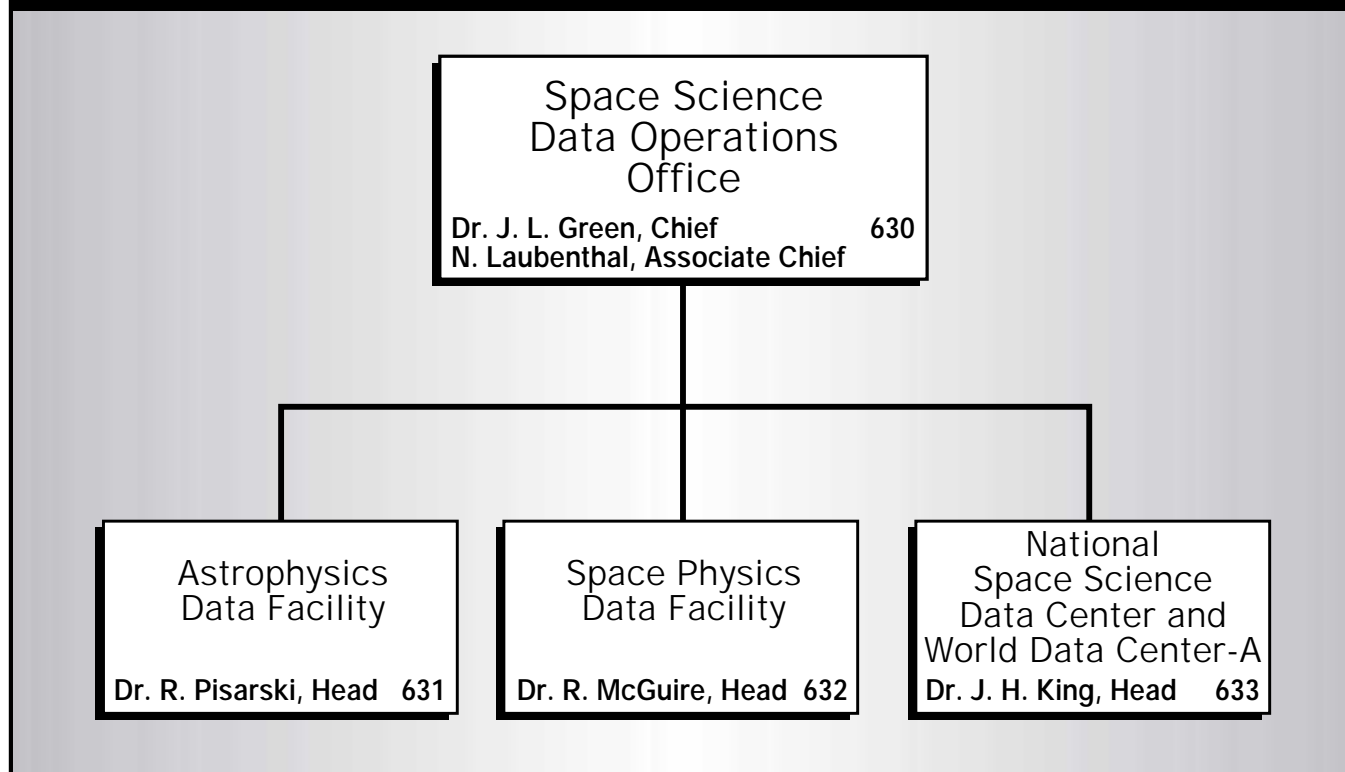
Goddard Space Flight Center's (GSFC) fundamental mission is to increase knowledge of the Earth, its environment, the solar system, and the universe through the development and use of spacecraft. GSFC has some of the world's leading groups of scientists, engineers, hardware and software developers, and administrative managers responsible for supporting NASA programs.

GSFC is organized into eight directorates as shown in the accompanying diagram. The Space Science Data Operations Office (SSDOO) resides within the Space Sciences Directorate.



SPACE SCIENCES DATA OPERATIONS OFFICE

Organization Chart



SPACE SCIENCE DATA OPERATIONS OFFICE



CODE 630

OVERVIEW

GSFC has long been active in the planning, acquisition, processing, analyzing, archiving, and dissemination of data from space science missions. The National Space Science Data Center (NSSDC) has archived and distributed the data of many scientific disciplines and facilitated research (with archival data) for over 30 years. Currently, GSFC is responsible for over 30 missions. The future data products derived from NASA and NASA involved international space science missions are growing substantially in volume and information content. This growth in data volume and complexity introduces unprecedented demands and new challenges on space science data operations and information management systems to archive, analyze, and distribute data to a diverse community of space scientists, educators, students, and the public at large. In June 1992 GSFC established the Space Science Data Operations Office (SSDOO) in order to meet many of these new challenges.

SSDOO has a large number of computer systems with public services that are all connected to open wide-area computer networks. These systems are heavily accessed by scientists as well as the general public. Because of this large investment in on-line data operations, systems, and services, the SSDOO is also responsible for the operation of the NASA Incident Response Center or NASIRC. This activity includes providing technical training in security awareness training, and developing and distributing computer security tool kits to NASA system managers and other computer users to adequately protect government computer resources.

The services of the SSDOO and its branches can be accessed over the World Wide Web starting at the URL:

<http://ssdoo.gsfc.nasa.gov>

CHARTER

The Space Science Data Operations Office manages and operates three major data intensive branches. SSDOO performs various space data operations activities ranging from managing selected operating spacecraft to the development and operations of data and information systems that support processing, management, archiving, and distribution of space physics, astrophysics, and planetary physics data and information. The data systems provide support for many of the laboratory research needs within the Space Sciences Directorate and the scientific needs of the

space science research community in general. SSDOO accomplishes its responsibilities through the archiving, cataloging, and dissemination of space science data and provides many specialized science support services and systems involving sensor algorithm development, processing, and mission administration and management.

The division is heavily involved in the science data operations of several key spacecraft and interfaces with the Flight Projects Directorate (Code 400), the Applied Engineering and Technology Directorate (Code 500), the Space Sciences (Code 600) laboratories, and the space science community.

SPECIAL FACILITIES

Two of the stated goals of NASA's Office of Space Science with regard to education and public outreach are to "use our missions and research programs and talents of the space science community to contribute measurably to the general elevation of scientific and technical understanding throughout the country," and to "share the excitement of discoveries and knowledge generated by Space Science missions and research programs by communicating clearly with the public." Perhaps the best - if not only - way to convey the qualities and dynamics of these complex phenomena to the non-scientist is to translate our scientific observations of these features into pictures and animations.

SSDOO has developed a Visualization Facility. The Facility creates illustrations, develops and produces 2D and 3D animations, and produces videos and quick time movies. This work is accomplished by working closely with members of the Space Science Directorate, key members of the space science community, NASA Headquarters, and GSFC Public Affairs Office. The finished products are available to the media, the education community and the general public.

ASTROPHYSICS DATA FACILITY



CODE 631

OVERVIEW

Space-based astrophysics missions are returning data sets of increasingly large volume and information content, challenging existing computational and data management systems and demanding new modes of operation. Specific Astrophysics Data Facility (ADF) functions include mission data system planning, data acquisition, data processing, algorithm development, guest investigator support, development of data access and visualization tools, and studies of new data technology utilization.

The ADF's primary customers are the providers and consumers of astrophysics data. These range from major NASA and international flight projects to individual researchers. The ADF recently completed highly successful support to the High Energy Astrophysics Archive Research Center (HEASARC, Code 662), guest investigators on the Roentgen satellite (ROSAT), Advanced Satellite for Cosmology and Astrophysics (ASCA), Rossi X-ray Timing Explorer (RXTE) missions by processing and dissemination of mission data. Similar activities are in the development stages for the SWIFT mission.

In collaboration with the Laboratory for Astronomy and Solar Physics (Code 680), the ADF manages the Cosmic Background Explorer (COBE) Guest Investigator Program. In addition, the ADF supports the Submillimeter Wave Astronomy Satellite (SWAS) and COBE missions through processing and dissemination of mission data.

The Astrophysics Data Facility:

- participates in data system planning and develops user support tools for the research community;
- processes level 0 data from both NASA and international astrophysics missions, and creates level 1 data products;
- develops and integrates state-of-the-art data systems necessary to carry out its mission; and
- functions as the scientific liaison between the NSSDC and astrophysics data providers identifying appropriate data from active and past missions.

CHARTER

Science data expertise provided by the ADF supports the processing, management, and dissemination of data obtained by past, current, and future NASA and international astrophysics missions. The ADF enables the effective use of those data (by providing IT tools and Computer Science methods to the astrophysics community, educators, and the public.

MAJOR ACTIVITIES

Science Data Processing for SWIFT - The ADF is providing science data processing pipeline development services to the SWIFT mission. This will include development of the pipeline and the software to convert telemetry to science data formats using the Flexible Image Transport System (FITS). The ADF will be supplying software to allow the pipeline to run at the SWIFT partner locations in Italy and the United Kingdom. After launch, the ADF will have responsibility for processing both fast (Quick Look) science data for quick delivery to science users and archival science processing for long term storage. The ADF will supply scientist access via the web to the Quick Look science data products. Long term public data storage support will be in the HEASARC while science data products will be delivered to Italy and the United Kingdom for their use as well.

New Technology Study for GLAST - The ADF is supporting the GLAST (Gamma Ray Large Area Space Telescope) mission by designing and prototyping a Beowulf-based archive system. Beowulf's are large clusters of commodity PC's running a common operating system (generally Linux). The design effort is to determine the value of commodity computer hardware and distributed processing for large astrophysics data sets.

HEASARC Support - The HEASARC was established at GSFC in 1990 to support multi-mission X-ray and gamma-ray archival research. The HEASARC makes high-energy astrophysics data accessible to the research community and provides expert scientific support to guest investigators. It is a collaboration between the Laboratory for High Energy Astrophysics (LHEA), the ADF, and the NSSDC. The HEASARC Director is a member of the LHEA. The ADF, is responsible for data management and interactions with other data centers, data producers, and science user support for some HEASARC supported missions such as ROSAT, ASCA, X-ray Timing Explorer (XTE), and Astro-E. The ADF works collaboratively with the HEASARC staff to help produce scientific analysis tools and simulations that are used by both the processing software and observers. This effort has been highly successful on ASCA.

COBE Guest Investigator Support - The ADF provides the international scientific community with on-line access to COBE data, and the public with access to images and information about the data and COBE's stunning scientific achievements. COBE-related educational resources including an online tutorial, a slide set, and a poster have been developed.

Astronomical Data Center and FITS Support Office - The ADF provides scientific guidance to the Astronomical Data Center (ADC) and the FITS Support Office. The ADC, part of a federation of international data centers that includes the Centre de Données astronomiques de Strasbourg (CDS) in France, acquires, verifies, formats, documents, and provides on-line access to files containing astronomical data in computer-readable form, and develops and maintains software tools to access the data. The FITS Support Office is responsible for documenting the FITS standard and participating in its evolution, advising persons involved in NASA astrophysics missions on how their data can be presented in FITS format, and providing on-line documentation for and limited user support directly to the research community.

Advanced Data Interface Development -The ADF staff in collaboration with the University of Maryland Institute of Advanced Computer Science is using Object-Oriented Data Base (OODB) methodology to build a new data-locating service, the Astrophysics Multispectral Archive Search Engine (AMASE). AMASE allows multispectral and multi-mission data in the NASA archives to be searched easily by scientific parameters. AMASE has a metadata base that links fundamental measurements published in astronomical catalogs with the relevant low-level mission data sets and the high-level mission data products in the archives. The scientific attributes searchable in the

AMASE prototype include astronomical names, positions, coordinates and classifications. Other parameters such as flux, color, proper motion and redshift will be searchable in later releases.

A complimentary effort undertaken by the ADF, which utilizes relational database methodology is the Web Interface for Searching Archival Research Data (WISARD) on the NASA Data Archive and Distribution Service (NDADS). WISARD has been developed in order to improve the accessibility of data archived on NDADS and to facilitate multi-wavelength, multi-mission research using the NDADS archives and related public archives. WISARD supports queries on fields which are uncommon between the various NDADS astrophysical catalogs (i.e. target coordinates and date of observation); choice of search epoch; access to the Set of Identifications, Measurements, and Bibliography for Astronomical Data (SIMBAD) name/coordinate resolver; catalog-specific field searches (e.g. instrument, object class, etc.); search criteria refinements; union and intersection queries on multiple catalogs; default and user-specified display of the query results; and subsequent NDADS and the Extreme Ultraviolet Explorer (EUVE) public archive data requests.

The Viewer/CATS EYE/Impress (VCI) interface is being developed also. It allows users to display, explore, cull, sort, manipulate and reformat data and metadata in catalogs and journal tables to meet the user's specific needs. Catalog information is available from the ADC, but the VCI allows data sets to be downloaded from other data centers in a convenient user friendly manner.

State-of-the-art information technology is being developed to enable users to obtain a better science yield from ADC's and other data center's holdings. The ADF is pioneering work on a new format XML which is starting to be utilized throughout the Space Science community. This format will allow the dynamic manipulation of journal tables and other data sets. Another area the ADF is pursuing concerns agent technology. These agents will enable the data centers to have more efficient data management and distributed computing.

SELECTED RECENT ACHIEVEMENTS

Mission Data Management Planning - The ADF advises Code 600 and external astrophysics projects on the formulation of their Project Data Management Plans (PDMP). These important documents describe the spacecraft-to-investigator flow of scientific data, and address related management and implementation issues. For example, the ADF collaborated with the Harvard-Smithsonian Center for Astrophysics to develop the SWAS PDMP and provided advice on ground data handling to the Microwave Anisotropy Probe (MAP) team. MAP is scheduled to be launched in 2001. SWAS data are available through web-based archive interface developed by the ADF.

Future Mission Planning - The ADF collaborates with the Code 600 Laboratories to develop plans for future space science missions. For example, we are participating in mission concept studies for the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS), and organized an international workshop on "Submillimeter Space Astronomy in the Next Millennium."

ROSAT Processing - ROSAT has been processing its final data sets to the final archival form (ROSAT Revision Level 2). In any flight mission, a small percentage of data sets have problems that reduce (usually only slightly) their full observing period. Even with a small percentage, the ROSAT mission has been so long and so productive that this represents a significant amount of data. In many cases, changes have to be made to programs to accommodate these minor data variations and this has required time. ROSAT has spent the last two years cleaning up these final problems to assure the highest quality final archive for use by the scientific community. As part of this effort, it became necessary to upgrade and test ROSAT software to assure correct functionality across the

1999-2000 date change boundary. This effort also consumed time and effort. ROSAT has now completed its processing and the US ROSAT Science Data Processing Center is shutting down.

ASCA Processing - ASCA has been processing mission flight during the reporting period. This proceeded quietly and without significant problems. During this period, the ASCA pipeline software was upgraded to support the 1999-2000 date change event. This required minor program and processing script changes and a significant testing effort. A parallel "time machine" ASCA processing pipeline was created to assure correct operation of the software. In July, 2000, the ASCA spacecraft was unexpectedly damaged by a large solar flare. Attempts by the Japanese to recover it failed. As a result, ASCA operations have been terminated. All ASCA data have been processed and a very small operation remains to assure ASCA proprietary data is released over the following year on time.

The ASCA team was also responsible for upgrading the ASCA science data processing pipeline to support the ASTRO-E mission during the reporting period. ASTRO-E would have been the follow-on mission to ASCA. This was accomplished by converting the ASCA Unix shell scripts to the (more portable) Perl language. The ASCA team was fully prepared for ASTRO-E operation when a launch vehicle failure caused the destruction of the ASTRO-E spacecraft in early 2000. The ASTRO-E processing operations were then cancelled.

XTE Processing and Distribution - The ADF processed and distributed AO1, AO2, AO3, and AO4 Rossi XTE (RXTE) data until October 1, 2000. Data processing and distribution operations were transferred to the RXTE Science Operations Facility on October 1, 2000 due to the need to consolidate operations as a result of budgetary constraints. The ADF successfully supported the RXTE mission for over 4.5 years with data processing and distribution services, including a complete reprocessing and re-distribution of the first-year mission data without impact to ongoing operations.

Thin-Foil X-ray Ray Tracing - The ADF created an X-ray ray tracing simulator for use by the ASCA and ASTRO E missions. This package traces X-ray photons through both the ASCA and ASTRO E telescopes and predicts the performance of the optics. This software has been integrated with the ASTRO E XRS simulator to allow the ASTRO E science community to plan optimal science use of this instrument.

Advanced Data Interfaces - Both AMASE and WISARD have achieved usefulness for the user community. This was in evidence by the interest generated by the ADF exhibit of both interfaces at the recent American Astronomical Association meeting in San Antonio. The AMASE prototype can be accessed on the Web at the URL: <http://amase.gsfc.nasa.gov/> and WISARD is accessible via the Web at: <http://hypatia.gsfc.nasa.gov/wisard/wisard.html>

The ADF has produced browser files for most of the NASA UV astronomical data holdings, including the IUE archive. These browsers enable researchers to preview data products and determine their applicability. In the spirit of interoperability, the browser pages are accessible from both the ADF WISARD interface and the Space Telescope MAST facility (<http://archive.stsci.edu/mast.html>). More recently, the ADF staff has begun to create tools which will facilitate data mining of the International Ultraviolet Explorer (IUE) archive. Specifically, the temporal behavior of objects observed 10 or more times over the 17 year lifetime of IUE can be investigated. As a first step in the mining process, a browser which displays dynamic spectra of each set of repeated observations was constructed. This facility enables a researcher to decide whether further analysis is warranted. It also provides a set of data which will guide the ADF staff in the development of automated tools which will be capable of attacking even larger data sets.

The ASCA mission is supported by the ADF in a similar fashion. The ADF processes all ASCA mission data into data products that are distributed to U.S. and European observers as well as to the HEASARC. Additional services include maintaining processing scripts, providing data management automation software, and providing World Wide Web (WWW) access to processing results information and documentation.

The ADF supports the XTE mission by providing processing, distribution and archiving using systems that were developed jointly for both ROSAT and ASCA. Level 0 data are processed and data products are generated that are provided to users. An additional requirement is for the ADF to provide the data to the instrument teams which are located at GSFC, University of California San Diego (UCSD) and Massachusetts Institute of Technology (MIT) so any anomalies can be identified and corrected. WWW access is also provided to help users determine the processing status of their data. *Future Mission Planning* - The ADF collaborates with the Code 600 Laboratories to develop plans for future space science missions. For example, we are participating in mission concept studies for the Submillimeter Probe of the Evaluation of Cosmic Structures (SPECs), and recently ran a successful workshop on "Submillimeter Space Astronomy in the Next Millennium."

ASCA Processing - The ADF has completed reprocessing all current ASCA flight data to the Revision 2 standard. This provides both archival scientists and proprietary Guest Observers with the highest quality data currently available. A copy of the ADF processed archive is being provided to the ASCA mission partner, the Institute for Space and Astronomical Studies (ISAS) in Japan. This will facilitate research by providing a common set of data to both sides of the Pacific. As is standard policy, all data is being supplied to the HEASARC as it is being processed.

XTE Processing and Distribution - The ADF has processed and distributed 95% of the AO1, AO2 and AO3 XTE data to date (350 Guest Observers). These observations began January 31, 1996. Many uncertainties in the processing and data distribution system had to be worked out. The ADF has completed reprocessing all current RXTE flight data to the Revision 1 standard. The ADF XTE team also provided all the data to the instrument teams using the internet and tape distribution. This insured that the hardware teams could verify the correct operation of the suite of observing instruments onboard XTE.

Thin-Foil X-ray Ray Tracing - The ADF created an X-ray ray tracing simulator for use by the ASCA and ASTRO E missions. This package traces X-ray photons through both the ASCA and ASTRO E telescopes and predicts the performance of the optics. This software has been integrated with the ASTRO E XRS simulator to allow the ASTRO E science community to plan optimal science use of this instrument.

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SPACE PHYSICS DATA FACILITY



CODE 632

OVERVIEW

The Space Physics Data Facility (SPDF) develops and operates a range of programs serving data needs of the NASA and international space physics science communities. Central efforts of SPDF are the WWW-based Coordinated Data Analysis Workshop Web (CDAWeb) and the Satellite Situation Center Web (SSCWeb) software development and science-enabling services. These services and other efforts of the SPDF support NASA's Sun-Earth-Connections (SEC) program, the International Solar-Terrestrial Physics (ISTP) program including international elements and the InterAgency Consultative Group (IACG) solar-terrestrial research initiative. Several members of SPDF play key roles in the science and ground systems of the upcoming IMAGE mission, as well as science investigator roles in ISTP, IMP-8 and the upcoming Cluster mission. SPDF and its systems have played key roles in the Space Physics Data System (SPDS) in collaboration with other elements of the SSDOO and the Space Science Directorate laboratories, and are a logical supporting element to the new Space Science Data Service (SSDS).

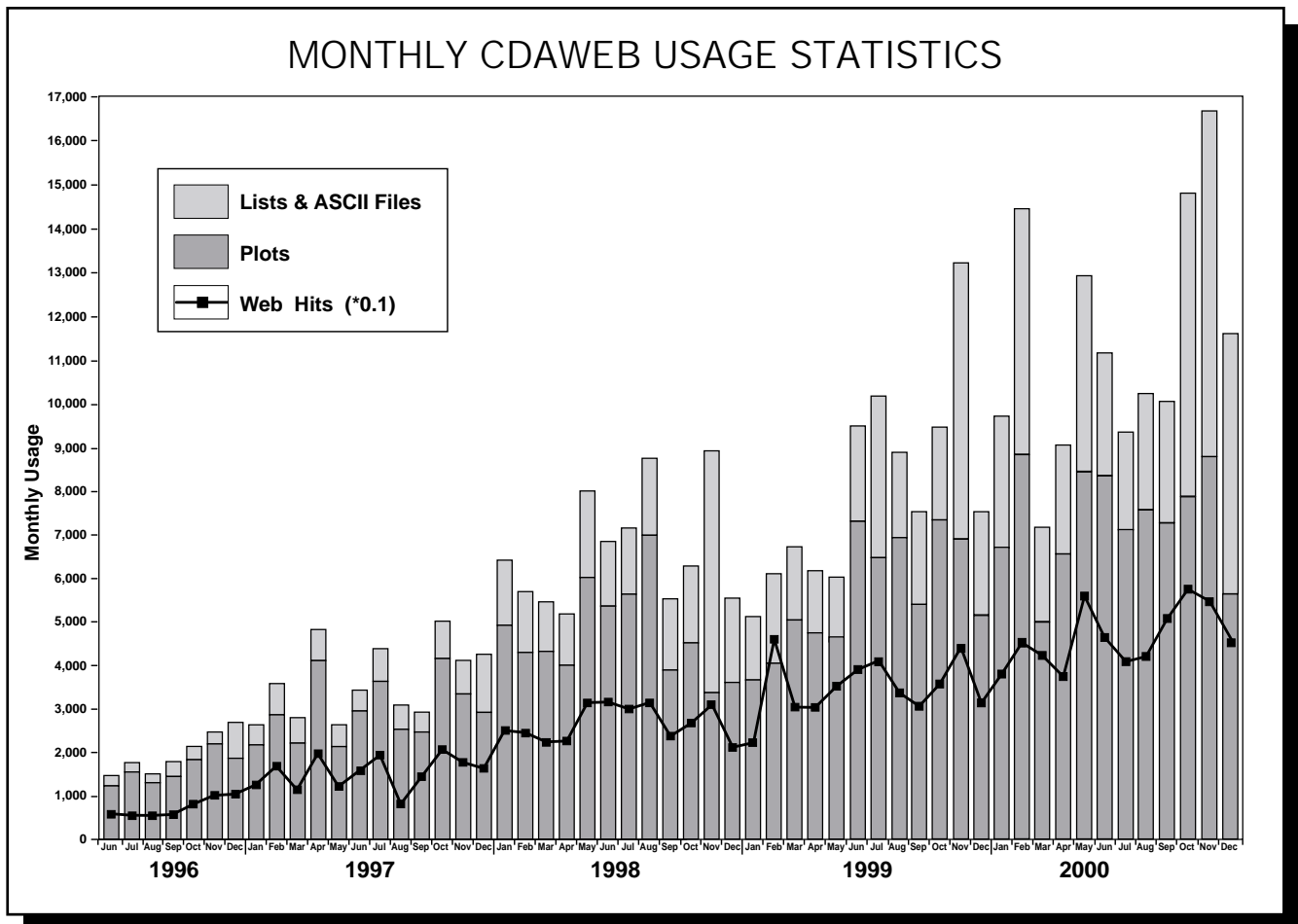
CHARTER

SPDF works closely with Code 600 laboratory and flight personnel in space physics data operations activities. SPDF develops and implements capabilities to serve space physics scientists' needs by supporting the creation and distribution of multi-source, multi-parameter, and multi-project data sets and data bases, "value-added" interdisciplinary data bases, and other products (e.g., CD-ROMs); develops such systems for specific NASA flight projects; and leads the development of nationally accessible advanced data base systems in the areas of solar-terrestrial physics. This includes the development, implementation, and operation of a WWW-based system for viewing and downloading multi-instrument space physics data (CDAWeb). SPDF works closely with flight project personnel in data system planning, utilization, and operation. SPDF designs and implements the SSCWeb software system, that provides mission planning information for scientists involved in the ISTP program supporting NASA and other agency spacecraft science operations planning. SPDF personnel represent the National Space Science Data Center as appropriate in interfacing with data producers to identify and coordinate the acquisition of appropriate space physics data from active missions. SPDF identifies and oversees loading of appropriate data to the active on-line/near-line space physics data archive and development of appropriate user interface and other tools for that environment. SPDF develops and integrates state-of-the-art capabilities and systems necessary to carry out its mission.

MAJOR ACTIVITIES

SPDF continues its role of enabling coordinated science in the tradition established by the Coordinated Data Analysis Workshop (CDAW) program. Taking advantage of the new WWW

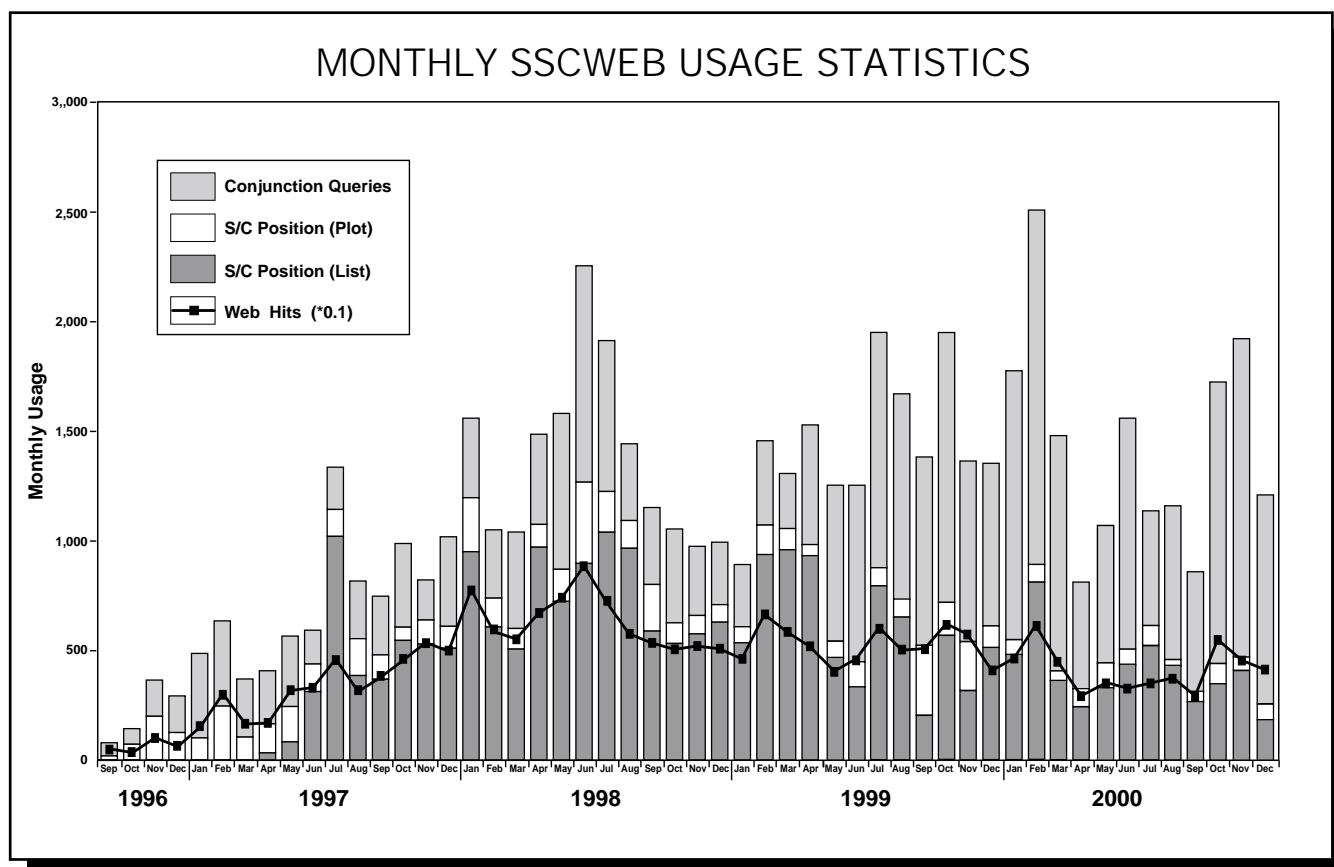
technology, CDAWeb now allows users to display or download simultaneous data from many investigators in order to attack significant physical problems of global scale that may not be otherwise addressable. The concept originated in the solar-terrestrial community within the International Magnetospheric Study (IMS) program to analyze simultaneous data from a variety of sources to understand better the structure and dynamics of the Earth's magnetosphere. The Inter-Agency Consultative Group (IACG) is presently sponsoring a series of science campaigns, all supported in one degree or another by the databases of CDAWeb. CDAWeb is hosting an increasing set of higher-resolution spacecraft products and products from an expanding range of missions beyond ISTP (e.g. FAST and ACE) including key non-NASA data for European Space Agency's (ESA) Ulysses missions and the Russian Interball Tail and Aurora spacecraft.



The Satellite Situation Center (SSC) consists of a software system, operational and development facilities, and an operational staff to support a range of science planning and science analysis needs where spacecraft orbital information must be brought into play with magnetic field models and magnetospheric region definitions. The operational SSC and the SPACEWARN (SW) offices support the Inter-Agency Consultative Group (IACG) program and populate on-line files of orbital elements and help carry out commitments to the Committee on Space Research/International Ursigram and World Days Service (COSPAR/IUWDS), and the Consultative Committee for Space Data Systems (CCSDS).

The operational SSC works closely with the ISTP Science Planning and Operations Facility (SPOF) to meet ISTP and IACG needs. SSCWeb supports both listing and graphics with the ability to perform sophisticated queries to identify times of specific spacecraft locations and various spacecraft-spacecraft and spacecraft-ground conjunctions. The system is designed to support

easily consistent updating of distributed, customized copies of the underlying data base from files generated at other facilities, for example the SSC's receiving orbit elements and then providing updates on IACG missions to the SPOF or the SPOF updating the SSC with respect to core ISTP missions. The full capability of an enhanced SSC software system and data bases are now publicly



accessible as SSCWeb as a joint SPDF/NSSDC effort. SPDF, in collaboration with NSSDC is making critical data-management related contributions to the Global Geospace Science (GGS), ISTP, and IACG programs. SPDF is defining the correct and most cost-effective use of key data standards, developing software against these standards to support specific program objectives and supporting a master near-line data archive.

One key activity is the support of ISP/GGS-IACG use of the NSSDC-developed and maintained Common Data Format (CDF) as a standard for Key Parameters (KPs). KPs are a time-continuous data product characterizing the physical measurements of each instrument from every investigation and are the key ISTP mechanisms supporting a "global" view of the data collected. SPDF has developed a further set of detailed "CDF Implementation Guidelines" as a foundation to enable ISTP to realize its desired global and holistic view of its data. These standards now form a baseline for international space physics exchange and have been endorsed by both the Cluster project and the IACG. SPDF has developed a new, Java-based tool to greatly ease the learning and implementation effort for data providers to cast data into ISTP-guidelines compliant CDFs.

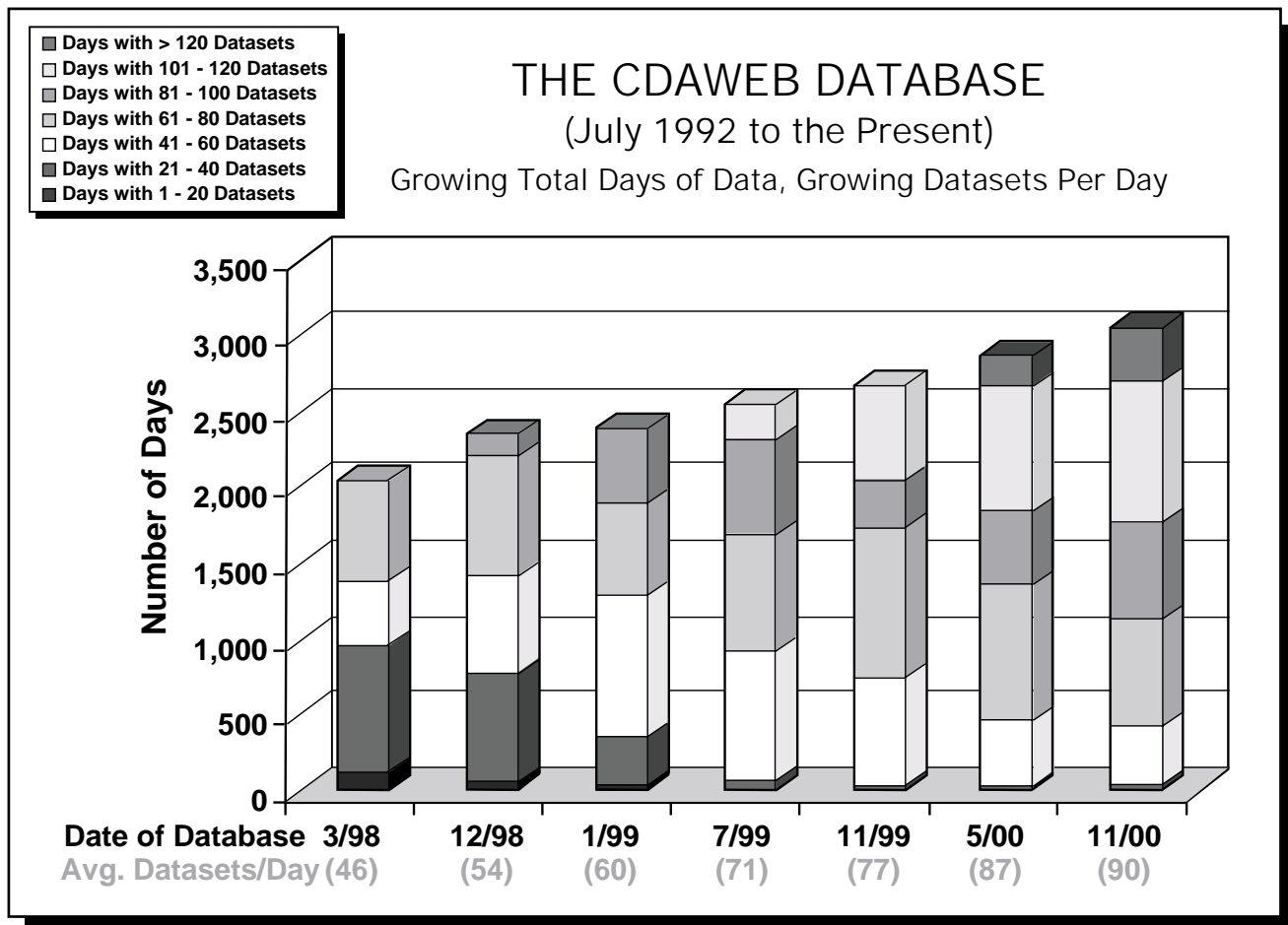
SPDF partners with NSSDC staff to provide technical oversight and other guidance to specific activities on behalf of NSSDC. These activities include the identification and acquisition of key space physics data; the creation of value-added data sets, such as the OMNI and Coordinated Heliospheric Observations (COHO) data bases; acquisition and dissemination of space physics models; and the furthered accessibility of key archival space physics data sets, for example, in loading them into NDADS and in developing simple and portable basic display software.

Actively involved in enabling coordinated science (IACG and ISTP) and data management, the Space Physics Data Facility is leading the definition of a new program in data-intensive radiation belt modeling. As follow-on to the traditional NSSDC Trapped Radiation Environment Modeling Program (TREMPE) that produced the existing NASA trapped radiation models, the SPDF is leading an effort to construct a new generation of trapped radiation models using modern data management technology (e.g., object-oriented database, data format standards, and modern communications tools). The model architecture is designed such that the models will have better performance and accuracy by being updateable, extensible as well as parameterize-able. Combining both empirical and theoretical modeling techniques, the new models will be semi-empirical such that they will be important tools suitable for both scientific and space weather applications.

SPDF staff actively define and lead a range of science instrument work (e.g. on IMP-8 IMAGE, and Cluster) as well as various funded Guest Investigator research efforts in e.g. trapped radiation modeling, solar/galactic cosmic ray studies and studies of the earth's bow shock using ISTP and other data. As one example, the bow shock study investigates the dynamic nature of Earth's bow shock to gain a new understanding the bow shock's position, shape, and motion, and the relationship between changes in the solar wind and the response of the bow shock. Studies are performed using the vast data resources of ISTP concentrating on three satellites: Geotail, IMP 8 and WIND. Using primarily Geotail at the Earth's bow shock with Wind and IMP 8 upstream as monitors, we investigate the source of the multiple bow shock crossings and whether or not the shock is ever still. We look at how the interaction changes based on solar wind nominal conditions such as Mach number, IMF direction and ram pressure. There are also configurations for which two or more spacecraft are nearly simultaneously crossing the bow shock. For these "events" we look for similar features at both crossings to attempt to answer the questions "does the bow shock move as a rigid body and under what conditions?"; and "does the rigid shape match the one predicted by local normals calculated in models.

SELECTED RECENT ACHIEVEMENTS

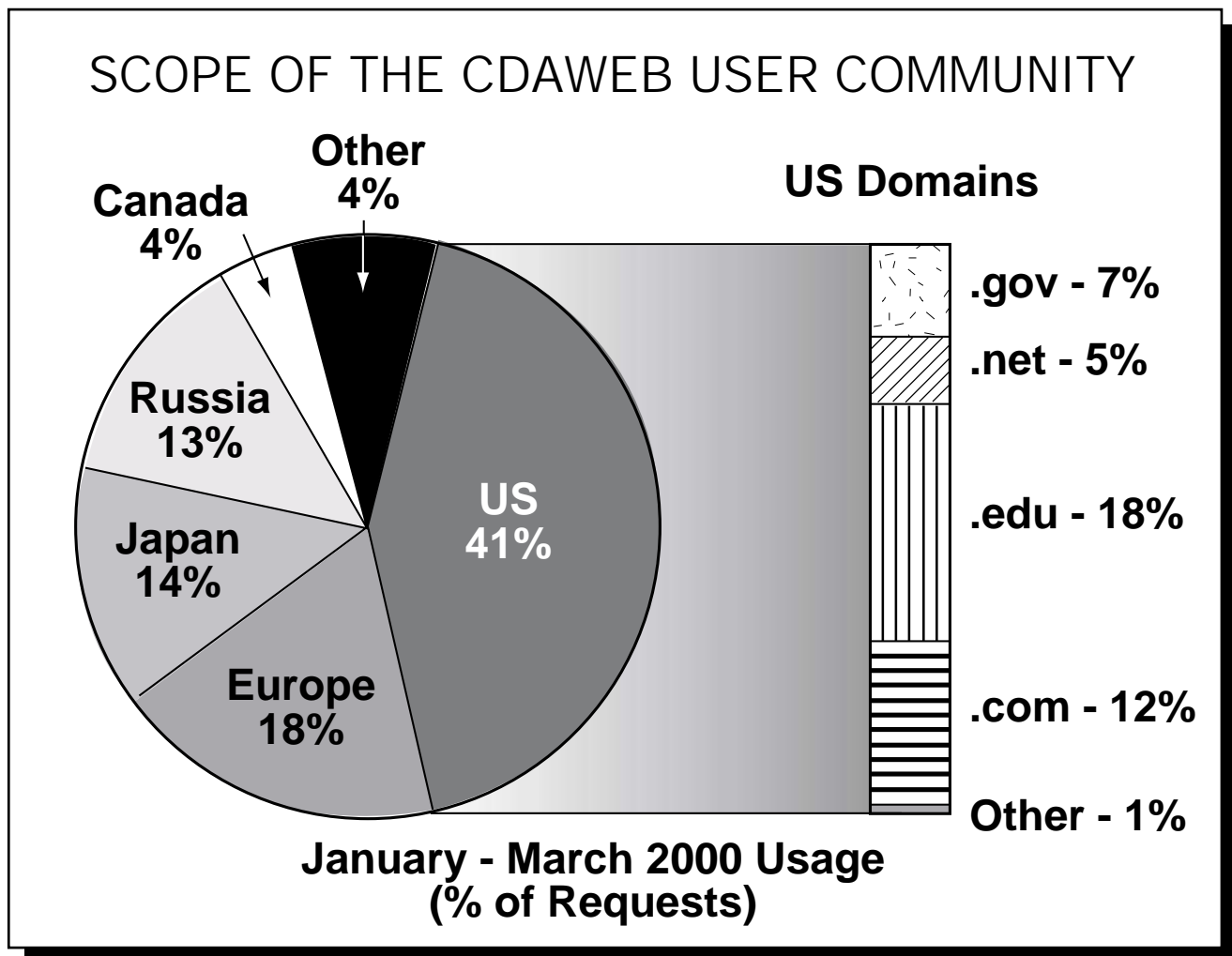
- The combined efforts of SPDF with its partners in the NSSDC and the ISTP SPOF were recognized by Goddard in granting a "National Resource" group achievement award to the "Sun-Earth Connections Coordinated Data Analysis Tools & Services Group" "For new capabilities and ongoing services enabling the best science community use of Sun-Earth Connections data to achieve critical NASA science program objectives." An earlier stage of much of this work was recognized by NASA by an Agency-level group achievement award in 1997.
- Use of the CDAWeb system continues steady growth since its operational start-up in 1996. From the graph of current usage shown, average use is now ~10,000 plots and listings per month with peaks ~15,000/month.
- The CDAWeb database now exceeds 200 GBytes and 300,000 files in size and includes some 1100+ science parameters. As seen in the second chart, as of November 2000, the database now includes ~3.5 years (1260 days) when there are >100 datasets with data in each of those days. A typical distribution of users is shown in the last chart and emphasizes the international user base for this service. CDAWeb is now supported by a dual-CPU workstation and has recently been upgraded to just slightly less than 1 TByte of total disk capacity.
- CDAWeb "mirror" sites have now been established at the Max Planck Institute in Garching, Germany, at the Rutherford Appleton Laboratory in the UK and at ISAS in Japan.



- Use of SSCWeb also continues steady growth, with usage now averaging ~1800 plots, listings and queries per month and peaks to >2600/month. The SSCWeb database now includes some 30 current missions, plus orbits from another 30 historical spacecraft and their objects.
- Data from all experiments on IMAGE is now being brought online into CDAWeb. Both Summary and Prime Parameters (investigators only at this time) from Cluster will be supported by CDAWeb when the Cluster spacecraft are made fully operational in January 2001. Special SSCWeb efforts have also been made to incorporate into SSCWeb project-generated orbits (definitive and predictive) for both missions.
- A Java-based application (SKTEditor) has been developed to support the ready definition of fully ISTP-guidelines-compliant CDFs appropriate as a basis for generation and ingest of new data products into CDAWeb. This tool acts as an intelligent interface to guide users in the structuring process. The makeCDF application is a complementary tool supporting the ready conversion of user data into CDF once the CDF structure is defined.
- The Imager for Magnetopause to Aurora Global Exploration (IMAGE) ground successfully supported IMAGE launch operations, early orbit and configurations and is now supporting IMAGE science operations. The system was designed and is being led by a key staff member in SPDF; the system was defined to a very constrained development budget but was nonetheless delivered on time and within budget.
- The bow shock study effort created a database of the Earth's bow shock crossings and provided web access to it in order to facilitate statistical studies and cross-comparisons. This

database stores a list of bow shock crossings as well as information associated with each crossing - solar wind parameters such as Magnetosonic Mach number, plasma beta, IMF Bx, By, Bz, bow shock angles and ram pressure. The database design allows several kinds of plots to be created for specific subsets of the database, the conditions specifying the subset supplied through the WWW-based interface. Plots such as bow shock crossing locations and surface normal directions are currently supported. The database presently holds 950 crossings of the Earth's bow shock flanks observed by the Geotail spacecraft. In addition J. Safrankova and Z. Nemecek supplied two years worth of Magion-4 (Interball-Tail's sub satellite) bow shock crossings approximately 1100 crossings). We plan to add IMP-8 and Wind bow shock crossings in the future.

The programs of SPDF are beginning to form a consistent framework and a solid foundation to address major challenges posed in data management and data handling by key Sun-Earth-Connections programs. The efforts will continue into the new millennium with the IMAGE and Cluster II missions.



NATIONAL SPACE SCIENCE DATA CENTER & WDC-A



CODE 633

OVERVIEW

The National Space Science Data Center (NSSDC) is a multidiscipline archive, supporting astrophysics, solar and space plasma physics, and lunar and planetary sciences. NSSDC acquires data from spaceflight projects, discipline data systems, and individual principal investigators. NSSDC permanently archives digital data in nearline and offline modes and archives other legacy data mainly on film. NSSDC disseminates data, primarily electronically, to the international space science community and both electronically and via offline mailings of CD-ROMs and film products to the general public.

The center maintains comprehensive information files about NSSDC-held and other data. Finally, NSSDC manages the NASA/Science Office of Standards and Technology (NOST). NSSDC is the permanent archive for most NASA space science mission data and is the active archive for much data in selected discipline areas. As an element of the SSDOO, NSSDC collaborates with other facilities of SSDOO, with the other laboratories of the Space Sciences Directorate, and with the public for accessing NASA archival mission data.

NSSDC's top web page is located at

<http://nssdc.gsfc.nasa.gov/>

Many details about NSSDC's holdings and services as of the end of 1999, and data inflows and outflows during 1999, are at the following URL. The 2000 NSSDC Annual Report is now in preparation and will shortly be at an equivalent URL.

<http://nssdc.gsfc.nasa.gov/nssdc/annual/1999/>

CHARTER

The National Space Science Data Center serves as the permanent long-term archive and distribution center for a broad range of space science satellite data and information. It is responsible for the maintenance and operation of discipline-independent directories,

data standards, and other information services; access to existing and future NASA space science archives; support as requested of data center node(s) for science discipline data systems; and participation in the development of a nationally accessible science data system.

The NSSDC maintains the necessary in-house expertise to support NASA data management, including related advanced information and storage technologies for distributed and intelligent data systems. The NSSDC develops and integrates state-of-the-art capabilities and systems necessary to carry out its mission and is responsible for maintaining useful products and publications. NSSDC is responsible for the operation of the World Data Center for Satellite information, which serves as NASA's agent for the international exchange of space science information and data.

MAJOR ACTIVITIES

NSSDC is responsible for the archiving and dissemination of scientific data from specific astrophysics and space physics missions and other discipline missions as appropriate. NSSDC manages the long-term space science and planetary archive and provides both electronic and off-line data distribution services. It maintains the long-term archive of both computer-readable and non-computer readable data (i.e., film) and preserves valuable information content against physical deterioration of the storage media.

The NSSDC interfaces with astrophysics, planetary, and space physics discipline data systems and with SSDOO's Space Physics and Astrophysics Data Facilities to ensure timely access to archived data and information. It may provide limited special services and value-added products or generate multidisciplinary data bases for the astrophysics, planetary, and space physics science communities. It produces regular publications promoting and informing the science user community of its archive contents and services. As assigned by NASA Headquarters, it assures the continuing accessibility of distributed NASA archived data files when the entities managing those files cease that activity.

NSSDC maintains expertise in information systems technologies and applies this knowledge to discipline-independent data systems and related services. It promotes data system interoperability.

NSSDC maintains a number of popular information systems. The NSSDC Master Catalog provides a wealth of information on past, present, and future spacecraft, including information on individual experiments and sensors for space science missions and data sets associated with them. Hyperlinks to further information or to data are provided if available. There is also information on NSSDC's customer community, web access to the most popular images NSSDC distributes, and catalog and online ordering capability for several hundred CD-ROMs.

In addition, NSSDC, through its NASA/Science Office of Standards and Technologies (NOST), leads the NASA activity in international standardization efforts for compatibility of distributed on-line scientific data and information files. It also defines, develops, and manages a set of generic services covering a wide range of space and Earth science disciplines. It develops and integrates state-of-the-art capabilities and systems necessary to carry out its mission.

NOST serves the NASA science communities in evolving cost-effective, interoperable data systems by performing a number of functions designed to facilitate the recognition, development, adoption, and use of standards by these communities. The development of new standards is supported through participation in the international Consultative Committee for Space Data Systems (CCSDS) Panel 2, the International Astronomical Union's Flexible Image Transport System (FITS) committees, and the NOST's FITS Technical Panel. Standards support is provided through support offices for the CCSDS Standard Formatted Data Unit (SFDU) standards and the International Astronomical Union (IAU) FITS standard and through the convening of the Formats Evolution Process to help the community better understand their standards and evolve more interoperable systems.

At this writing, NSSDC is migrating about 1 TB of space physics and astrophysics data from its legacy NDADS system (network-attached VMS-based optical disk jukeboxes) to magnetic disk for convenience of user access.

SELECTED RECENT ACHIEVEMENTS

The most important result of NSSDC's 2000 activities is the continuing preservation of growing space science data volumes, ensuring their continuing and future accessibility to the space science, education and general public communities. At this writing, NSSDC's 2000 full annual statistics are still being compiled, but it can be noted that during 2000 NSSDC ingested about 1.7 TB of data, bringing its total to just over 20 TB of data from 1400 experiments flown on 420 spacecraft.

NSSDC continues to distribute large amounts of data by network to the space science community and general public, and by offline mailings to the general public. During 2000, NSSDC's customers downloaded about 2.3 million data files (15% increase over 1999) and had 1170 requests satisfied by NSSDC's mailing CD's or photoproducts via the U.S. mail.

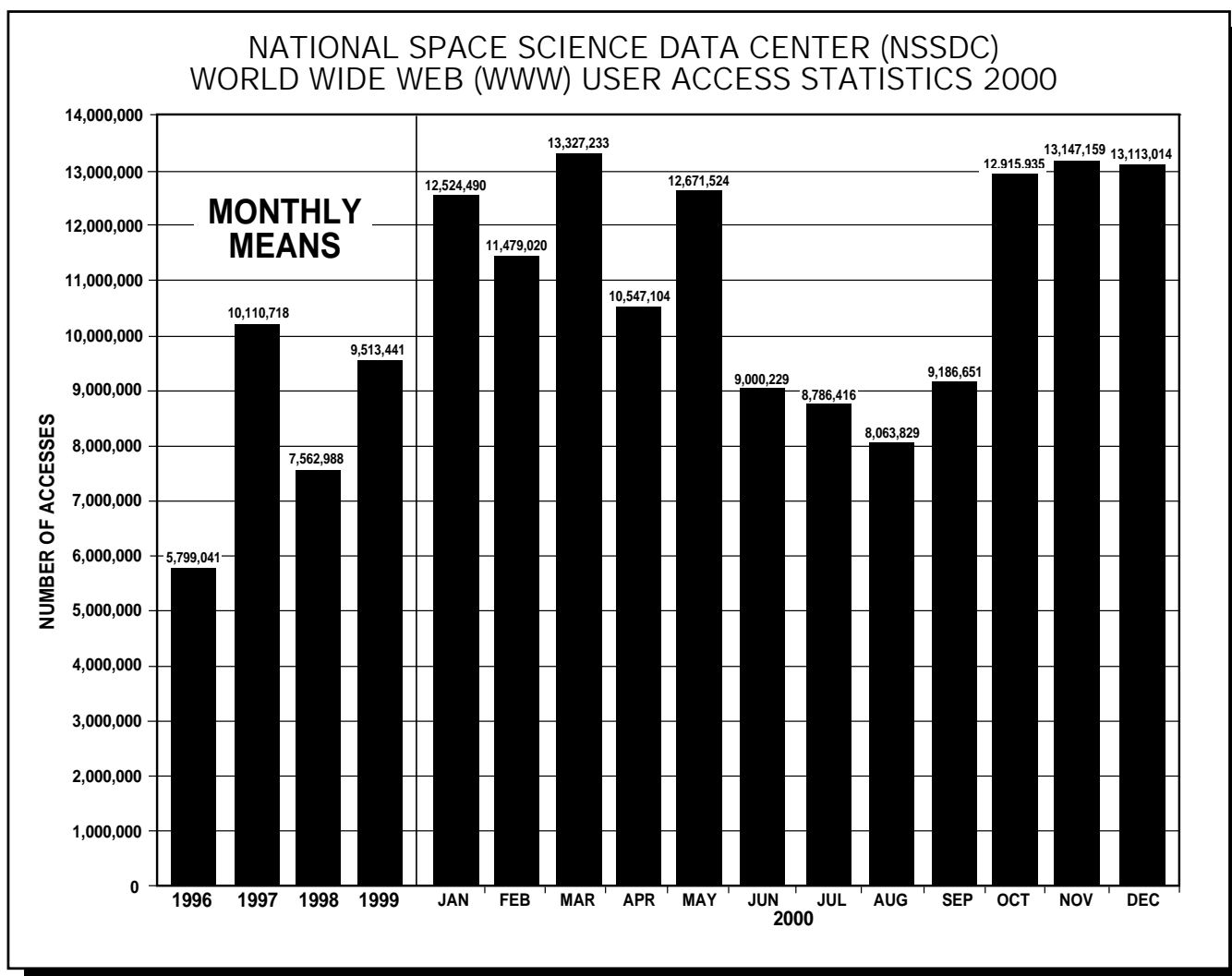
NSSDC's data dissemination is leading to the publication of significant new science. The Appendix of the 1999 Annual Report listed 47 science papers acknowledging NSSDC data or services as contributing to their analyses. These are papers which have come to the attention of our staff. Most science journals in which NSSDC data or services may have been used are not reviewed by our staff routinely, so the list represents a lower limit on papers enabled or benefitted by NSSDC. The equivalent list of year-2000 papers will appear in the 2000 Annual Report.

The year 2000 marked the start of multiple data management advances at NSSDC. Archive Information Packages (bundles of data files and companion attribute files as prescribed by the ISO/CCSDS Archive Reference model) were defined, created and written to DLT jukebox thereby initiating a gradual transition of NSSDC's permanent digital archive from offline shelves to nearline jukeboxes.

At the same time the AIPs' constituent data and attribute files are being written to a new unix-based RAID magnetic disk environment (cf.<ftp://nssdcftp.gsfc.nasa.gov/>). Data previously ftp-accessible from other NSSDC systems are also being written to the same location. The first data being packaged as AIPs are the space physics data and IRAS data on NSSDC's VMS-based optical

on these data management changes are given in the web-accessible NSSDC Newsletter (December, 2000).

NSSDC developed a new family of graphical-display-and-subset interfaces for selected ftp-accessible ASCII and gzipped-ASCII data sets that are awaiting possible conversion to Common Data Format for support by CDAWeb. This family, called Ftp-helper, aids in the data preview and selection process. See <http://nssdc.gsfc.nasa.gov/ftp-helper/>.



Through its NASA/Science Office of Standards and Technology (NOST), NSSDC provides international leadership in providing increasingly effective digital data archiving. During 2000, the NOST-led Formats Evolution Process Committee prepared and released for community review a paper proposing a possible time series object that could lead to improvements in the science community's ability to understand and process time series data. Also, there was growing world-wide acceptance of the NOST-led, ISO/CCSDS-sponsored Archive Reference model and use of this model in refashioning NSSDC's own data management approach as mentioned above.

There was high-level interest in 2000 in the recovery and digitization of data from the Labelled Release biology experiment flown to Mars on the two Viking Lander spacecraft. NSSDC played a key role, along with the Planetary Data System's Geosciences node and with two members of the original science team, in effecting this. Much keypunching was done from NSSDC-

microfilmed numeric listings and from newly-provided numeric listings on paper. This newly digitally available data set is supporting new "Life on Mars?" analyses.

Two other notable data rescue efforts occurred in 2000. First, a unique IMP 8 magnetotail electron data set available only as numeric listings (and plots) on microfilm was scanned and passed through Optical Character Recognition. The resulting ASCII files were manually cleaned and made ftp-accessible. Also, NSSDC began a systematic conversion of its film archive to computer-accessible TIFF format with the scanning of Magellan 10"x10" film (Venus imagery) and Mariner-series 70-mm film (Venus and Mars imagery).

NSSDC provided a leadership to the NASA Sun Earth Connection (SEC) Education Forum (SECEF), sponsored by the NASA SEC enterprise of the Office of Space Science. In particular, SECEF played key roles in year-2000 creations of (1) a new web-accessible space science education resource directory and (2) a new "Making Sun-Earth Connections" CD-ROM with various sections oriented to various subsets of the K-12 population.

PERSONNEL KUDOS



Over the last year the Space Science Data Operations Office employees below have been recognized for the following awards and honors:

GSFC Annual Awards

Solar Eruptive Events CDAW Organization Team

James Green, Code 630
Robert McGuire, Code 632
Shing Fung, Code 632
Margie Pasini, Code 630
Bobby Candey, Code 632
Greg Goucher, Code 633
Jennifer Ash-Poole, Code 630, Raytheon ITSS
Sean McKeown, Code 630, Raytheon ITSS
Russ Dunlap, Code 630, Raytheon ITSS
Emre Kaymez, Code 630, KT-Tech
Jim Palmer, Code 630, Raytheon ITSS
Tami Kovalick, Code 630, Raytheon ITSS

National Resource Award

Dr. Ramona Kessel

Excellence in Outreach Award

Jim Thieman

GSFC Quarterly Awards

Outstanding Manager Award

James L. Green

Outstanding Teamwork Award

Information Technology Self Assessment Team

Jim Green , Code 630
Nancy Laubenthal, Code 630

Outstanding Civil Servant Award

Rick Burley

Education and Outreach

Carol Krueger

National Awards

The Communicator Crystal Awards

"Blackout" Video

- Education
- Animation/Special Effects

The Telly Award

"Blackout" Video

The U.S. Department of Justice, Federal Bureau of Investigation Award

"In recognition for outstanding assistance to the FBI in connection with its investigative efforts"

Ms. Laura Carriere, SSDOO

Mr. Eric Scanland, NASIRC

Mr. Tom Baxter, NASIRC

Other Awards

Raytheon Technical Excellence Award

Ed Shaya

Civil Servant 2000 Peer Awards

George Fleming

Nat James

Lisa Kelly

Corporate Good Citizen Award

Lou Mayo/Raytheon ITSS

Community Good Citizen Award

Ralph Post/Raytheon ITSS

Support Services Award

Julie Smith/Raytheon ITSS

Team Achievement - SSDOO Metrics Tracking System Database (MTSDB) Team

Maia Good

David Guell

Teresa Hall-Jackson

Pat McCaslin

Edward Pier

Ralph Post

Patricia Ross

Ed Wilson

The Goddard Contractor Excellence Award Development Team

Raytheon ITSS

Raytheon ITSS Peer Awards

Ken Anderson

Jim Blackwell

MISSIONS, SCIENCE, AND IT RESEARCH & DEVELOPMENT



SPACECRAFT MISSIONS

IMAGE Mission

James L. Green, Col
Shing Fung, Col
Bill Taylor, Col

Wind and Polar

James L. Green, Deputy Project Scientist

IMP8 Mission

Joseph H. King, Project Scientist
Robert McGuire, Col

Voyager

Robert McGuire, Col

SPACECRAFT MISSION STUDIES

Workshop on Submillimeter Space Astronomy in the Next Millennium

David Leisawitz, Col

Submillimeter Probe of the Evolution of Cosmic Structure (SPECs) - Design Studies

David Leisawitz, Col

INFORMATION SYSTEMS R&D

Automated Processing of ISIS Topside Ionograms into Electron Density Profiles

Dieter Bilitza, Col

Satellite Ion/Electron Density/Temperature Data on CD-ROM and WWW

Dieter Bilitza, PI
Natasha Papitashvili, Col

Constellation Client - Server Architecture Testbed

Cynthia Cheung, Col

Development of a Space Science Data System Federation Interoperability Substrate using MOCHA

Cynthia Cheung, PI

Rapid Detection of Magnetospheric Boundaries

James L. Green, PI

Space Sciences Visualization Laboratory - Render Farm

Mona Kessel, PI

Analysis, simulation, assimilation, and prediction based on Multi-spacecraft data

Mona Kessel, Col

Development of a 25 year IMP-8 Bow Shock list and Provision for Web-based Access

Joseph H. King, PI

Interoperable Systems for Archival Information Access (ISAIA)

Joseph H. King, Col

Cynthia Cheung, Col

Investigation of An Active Tethered Distributed Spacecraft Architecture

David Leiswitz, Col

Wide Field Imaging Interferometry Testbed (WIIT) - Technical Equipment

David Leisawitz, PI

Remote Control of Vulnerability Scanning Devices Pilot

Richard Schneider, PI

Application of XML to Documentation and Content-Based Searching of Astronomical Catalogs

Edward J. Shaya, PI

Jim Gass, Col

Cynthia Cheung, Col

Autonomous Distributed Spacecraft Control, Science Collection and Advanced Simulation Technology

Mike Van Steenberg, PI

Improved IUE High Dispersion Extracting Software

Mike Van Steenberg, PI

SCIENCE

International Solar Terrestrial Physics (ISTP) Guest Investigator Program

Scott Boardsen, Col

AXAF Investigation of the Archtypical ULIRG: Arp 220

Kirk Borne, Col

Do Massive Star Clusters Form in Young and Weak Galaxy Interactions?

Kirk Borne, Col

The Redshift Dependence of the Interaction-Activity Connection among Ultraluminous Starbursting Galaxies

Kirk Borne, PI

Snapshot Survey of Dynamically Close Galaxy Pairs from $z=0.1$ to $z=0.5$

Kirk Borne, Col

Space Weather: Improved Global Specification of the Topside Ionosphere

Dieter Bilitza, PI

Energetic Ion Interactions with the Galilean Satellites

John Cooper, PI

Ed Bell, Col

Investigation of Plasma Flow Characteristics in the High-Latitude Cusp Region

Shing Fung, PI

Lun Tan, Col

Interpretation of Cluster data in the vicinity of the Earth's Bow Shock

Mona Kessel, PI

Identification of M Supergiant + B star Binaries in the Magellanic Clouds

Derck Massa, PI

FUV Diagnostics of Structure in Hot Star Winds

Derck Massa, Col

Cosmic Infrared Background Fluctuations from the WIRE Infrared Explorer

Sten Odenwald, Col

Investigating Cosmic Background Fluctuations in the Infrared Using COBE/DIRBE Data

Sten Odenwald, Col

FOS Spectroscopy of NGC 1316: Fornax A

Edward J. Shaya, Col

Science team for the Space Interferometry Mission (SIM): Dynamical Observations of Galaxies

Edward J. Shaya, PI

Derivation of the Inverse Compton and Extragalactic Components of the Large-Scale Gamma-Ray Emission: Implications for the Possible Existence of a Galactic Gamma-Ray Halo."

Tom Sodroski, PI

Nils Odegard as Co-I

Radio Plasma Imaging

William Taylor, PI

James L. Green, Col

Galaxy Winds vs. Cooling Flows in Poor Clusters

Richard White, Col

EDUCATION AND OUTREACH

Interaction of Magnetospheric Particles Applied to Classroom Teaching (IMPACT)

John Cooper, PI

Ed Bell, Col

Dave Williams, Col

GSFC Career Connection Model

Nathan James, PI

Lou Mayo, Col

AURORA: Using the Northern Lights to Enhance Rural Alaskan School Curricula

Sten Odenwald, PI

Interactive NASA Space Physics Ionospheric Radio Experiments INSPIRE

William Taylor, PI

James L. Green, Col

Sun-Earth Connection Education Form

James Thieman, Col

Radio JOVE

James Thieman, PI

Chuck Higgins, Col

James L. Green, Col

Bill Taylor, Col

Jim Gass, Col

Lou Mayo, Col

Radio JOVE Online Observatory

Jim Thieman, PI

Chuck Higgins, Col

PUBLICATIONS



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- Latest NSSDC Archive Plan Now on Web
- GSFC Space Science Director Head Retires
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- Vampola Data Sets from DoD Satellites Now at NSSDC
- Summer Interns Star at NSSDC/SSDOO
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- NSSDC Web Site Selected to Showcase NASA's Commitment to Accessibility
- David Han Finishes NSSDC Tour

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- NSSDC Canonical File
- Functions of the DIONAS and Related Software
- Visitors from Spain and Czech Republic at NSSDC
- Software Development Approaches and Teaming at NSSDC
- Meet NSSDC's Data Management Software Developers
- International Meeting of World Data Center Directors Held
- SWAS Data Available
- Data Preparation and Transfer Operations
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ACRONYMS



AAS	American Astronomical Society
ACE	Advanced Composition Explorer
ADC	Astronomical Data Center
ADF	Astrophysics Data Facility
ADS	Astrophysics Data System
AGU	American Geophysical Union
AMASE	Astrophysics Multispectral Archive Search Engine
ASCA	Advanced Satellite for Cosmology, and Astrophysics
ASCII	American Standard Code for Information Interchange
BAAS	Bulletin of the American Astronomical Society
CCSDS	Consultative Committee for Space Data Systems
CDAW	Coordinated Data Analysis Workshop
CDF	Common Data Format
CD-ROM	Compact Disc-Read Only Memory
CDS	Centre de Données Astronomiques de Strasbourg
CENDI	Commerce-Energy-NASA-Defense-Interior
COBE	Cosmic Background Explorer
CODATA	Committee on Data for Science and Technology
COHO	Coordinated Heliospheric Observations
Col	Co Investigator
COSPAR	Committee on Space Research
DIONAS	Data Ingest and Online Access Services
DIRBE	Diffuse Infrared Background Experiment
DLT	Digital Linear Tape
EGS	European Geophysical Society
EOS	Earth Observing System
ESA	European Space Agency
EUV	Extreme Ultraviolet Explorer
FAST	Fast Auroral Snapshot Explorer
FITS	Flexible Image Transport System
FTP	Anonymous File Transfer Protocol

GGS	Global Geospace Science
GLAST	Gamma Ray Large Area Space Telescope
GSFC	Goddard Space Flight Center
HEASARC	High Energy Astrophysics Science Archive Research Center
IACG	Inter-Agency Consultative Group
IAU	International Astronomical Union
IMAGE	Imager for Magnetopause-to-Aurora Global Exploration
IMP	Interplanetary Monitoring Platform
IMS	International Magnetospheric Study
INSPIRE	Interactive NASA Space Physics Ionospheric Radio Experiments
INTMINs	INTerball Mir INSpire
IRAS	Infrared Astronomical Satellite (The Netherlands-NASA-U.K.)
ISAS	Institute for Space and Astronomical Studies
ISO	Interoperable Systems Office
ISTP	International Solar-Terrestrial Physics
IUE	International Ultraviolet Explorer (satellite, NASA-U.K.-ESA)
IUWDS	International URSIGRAM and World Days Service
KP	Key Parameter
LEPEDEA	Low Energy Proton and Electron Differential Energy Analyzer
LHEA	Laboratory for High Energy Astrophysics
MAP	Microwave Anisotropy Probe
MD	Master Directory (NASA)
MIDEX	Mid-Sized Explorer Projects
MIT	Massachusetts Institute of Technology
NASA	National Aeronautics and Space Administration
NASIRC	NASA-Wide Automated Systems Incident Response Capability
NDADS	NSSDC Data Archive and Distribution Service
NOST	NASA/Science Office of Standards and Technology
NSSDC	National Space Science Data Center (NASA)
NSTA	National Science Teachers Association
OAIS	Open Archival Information System
OODB	Object Oriented Data Base
PDMP	Project Data Management Plan
PDS	Planetary Data System
PI	Principal Investigator
POETRY	Public Outreach, Education, Teaching and Reaching Youth
R&D	Research and Development
RITSS	Raytheon Information Technology and Scientific Services
ROSAT	Roentgen Satellite
RPI	Radio Plasma Imaging
RXTE	Rossi X-Ray Timing Explorer

SFDU	Standard Formatted Data Unit
SGML	Standard Generalized Markup Language
SIMBAD	Set of Identifications, Measurements, and Bibliography for Astronomical Data
SPDF	Space Physics Data Facility
SPDS	Space Physics Data System
SPECS	Submillimeter Probe of the Evaluation of Cosmic Structures
SPIE	Society of Photo-Optical Instrumentation Engineers
SPIRIT	Space Infrared Interferometric Telescope
SPOF	Science Planning and Operations Facility
SpyCat	Space Physics Catalog
S-RAMP	STEP Results, Applications, and Modeling Phase
SSC	Satellite Situation Center
SSDOO	Space Science Data Operations Office
SSDS	Space Science Data Service
STEP	Solar Terrestrial Energy Program
SW	SPACEWARN
SWAS	Submillimeter Wave Astronomy Satellite
TIFF	Tagged Interchange File Format
TREMP	Trapped Radiation Environment Modeling Program
UCSD	University of California San Diego
ULF	Ultra Low Frequency
ULIRG	Ultra Luminous Infra Red Galaxy
URL	Universal Resource Locator
UV	Ultra Violet
VCI	Viewers/CATS EYE/Impress
VMS	Vax Management System
WDC-A-R&S	World Data Center-A for Rockets and Satellites
WISARD	Web Interface for Searching Archival Data
WWW	World Wide Web
XDF	eXtensible Data Format
XML	Extensible Markup Language
XTE	X-ray Timing Explorer

